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REVIEW

Chest-Compression Alone Cardiopulmonary Resuscitation: Newer Data for a More Practical Approach/ Cardio-Cerebral Resuscitation

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KEY WORDS: *sudden cardiac death; out of hospital cardiac arrest; chest-compression alone cardio pulmonary resuscitation; cardio-cerebral resuscitation*

Abbreviations
AED = automatic external defibrillator
AHA = American Heart Association
CC-CPR = chest-compression cardio pulmonary resuscitation
CCR = cardio-cerebral resuscitation
CPR = cardio pulmonary resuscitation
EMS = emergency medical services
ILCOR = International Liaison Committee on Resuscitation
OHCA = out of hospital cardiac arrest
PCI = percutaneous coronary intervention
ROSC = return of spontaneous circulation
SCD = sudden cardiac death

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ABSTRACT

BACKGROUND: Sudden cardiac death (SCD) is a leading cause of mortality in the industrialized nations and, accordingly, is a major public health problem. Despite the guidelines and their updates, the survival rate of victims of out of hospital cardiac arrest (OHCA) remains disappointingly low. There are many contributors to poor survival outcome of victims with OHCA. An improper resuscitation algorithm seems to be the major contributor. Chest-compression alone cardio pulmonary resuscitation (CC-CPR), and cardio-cerebral resuscitation (CCR), seems an attractive alternative to conventional CPR.

METHODS & RESULTS: Reviewing the recent literature, cardiac-only resuscitation emerges as an attractive alternative to conventional CPR, as this simpler technique of CPR, in which continuous chest compressions are provided without rescue breathing avoids the need for mouth-to-mouth ventilation. Under the weight of evidence supported by several recent studies, the AHA issued a science advisory for the public recommending immediate activation of emergency medical services (EMS) after the victim's collapse and high quality chest compression regarding location and depth with minimum interruptions. Bystanders not trained in CPR are encouraged to initiate immediately hands-only CPR and continue with compressions until an AED is available or EMS arrives at the scene.

CONCLUSION: CC- CPR and CCR is not inferior to conventional CPR but also promises a survival benefit for victims of OHCA.

INTRODUCTION

Sudden cardiac death (SCD) is one of the leading causes of mortality in Europe. The survival rates for victims of out-of-hospital cardiac arrest from SCD are dismal despite the development and periodic updating of guidelines for cardiopulmonary resuscitation (CPR) and emergency cardiovascular care from the American Heart Association (AHA)[1] and the International Liaison Committee on Resuscitation (ILCOR)[2]. Bystander CPR can substantially improve outcomes, but it is provided in less than one in four cases of out of-hospital cardiac arrest. Aversion to mouth-to-

mouth breathing[3] or the more complex skills needed in order to provide adequate ventilation are thought to underlie the low rate of bystander CPR. Over the past few decades there is a trend towards minimizing interruptions for chest compressions by changing the compression-ventilation ratio in favour of chest compressions but there is no evidence that this offers an advantage in regards to the outcome.

An attractive alternative to conventional CPR that avoids the need for mouth-to-mouth ventilation is cardiac-only resuscitation, the chest compression alone cardiopulmonary resuscitation (CC-CPR), in which continuous chest compressions are provided without rescue breathing or cardiocerebral resuscitation (CCR) (Fig. 1), in which less mouth-to-mouth ventilation is performed.

PROBLEMS WITH CONVENTIONAL CPR

In the 60s ventilation was considered crucial for any resuscitation effort. There was a common belief that pulseless apneic patients can recover after ventilation of the lungs alone. It was also considered futile to resuscitate a victim by "closed chest cardiac massage" alone. So lay persons and professional rescuers were instructed to ventilate with sufficient pressure in order to reopen collapsed bronchioles and alveoli and to overcome increased airway resistance possibly produced by mucus and the absence of elastic recoil of the chest.[4]

New data demonstrate that any incidence of hyperventilation is likely to have detrimental hemodynamic and survival consequences during low flow states such as CPR. At the scene of out-of-hospital cardiac arrests ventilation frequency, duration, and percent positive airway pressure performed by professional rescuers were observed to be far in excess of those recommended, contributing in hemodynamic deterioration and decreased coronary perfusion.[5] The experimental data not only elucidated the pathophysiologic mechanisms of ventilation during CPR but also put under question the necessity of any ventilating effort.[6,7]

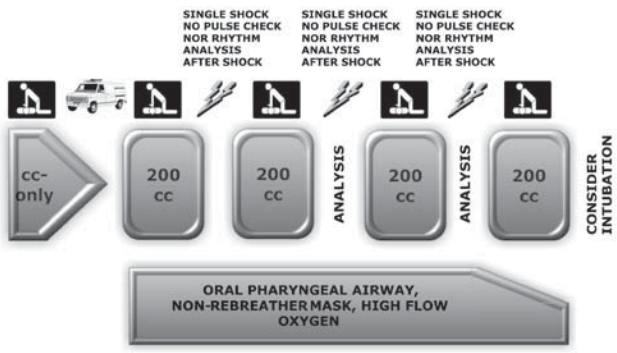

FIGURE 1. Cardiocerebral resuscitation protocol for out of hospital cardiac arrest (cc: cardiac compressions).

Another concern with attempted rescue breathing during CPR is the amount of air that enters the stomach rather than the lungs. Mouth-to-mouth ventilation can cause regurgitation in nearly 50% of patients, probably because of gastric insufflation. Lawes and Baskett reported that 46% of nonsurvivors from cardiac arrest had full stomachs and 29% had evidence of pulmonary aspiration.[8]

It is also well known that there is a substantial decrease in aortic diastolic pressures during the time spent for 2 rescue breaths, and both aortic and coronary perfusion pressure need approximately 3 to 7 chest compressions of the next series of consecutive compressions in order to reach a plateau phase.[9] In order to avoid the adverse hemodynamic effects of frequent interruptions in chest compressions for rescue breathing the compression:ventilation ratio changed in favour of compressions (from 15:2 to 30:2).[10,11] The initial 2 rescue breaths were also omitted for the same reason[1,2] (Fig. 2).

The 3-phase time-sensitive model from Weisfeldt and Becker[12] clarified the mechanism of cardiac arrest with the initial rhythm being ventricular fibrillation (VF). The first

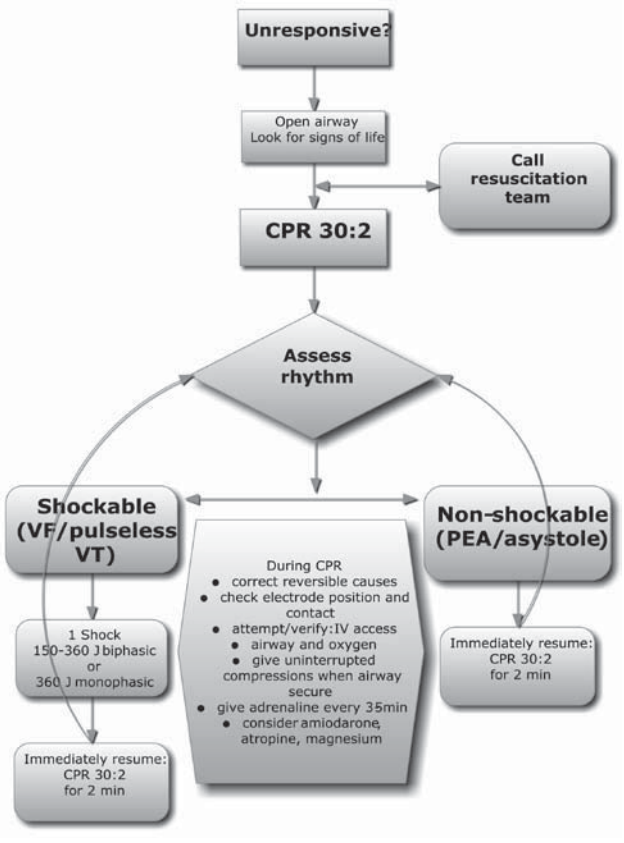

FIGURE 2. Advance life support algorithm (CPR: cardio pulmonary resuscitation, VT: ventricular tachycardia, VF: ventricular fibrillation, PEA: pulseless electric activity).

phase consists of an *early electrical phase* which lasts about 5 minutes and the most important intervention is defibrillation. This is why public access defibrillation programs (using automatic external defibrillators - AED) have saved lives in a wide variety of settings, including airplanes, airports, casinos, and the community.

The second phase, called the hemodynamic or circulatory phase varies in duration from 5 to 15 minutes from the onset of VF arrest. In this phase electrical defibrillation prior to circulatory support is typically unsuccessful resulting almost in a pulseless rhythm, either asystole, or pulseless electrical activity. Successful resuscitation during this phase requires not only pre-shock chest compressions but also prompt, effective post-shock resumption of chest compressions.[13] Finally, a *late metabolic phase*, starting after 15 minutes is the least successful phase of any rescue effort, requiring innovative and new approaches.

The three phase model with different therapeutic priorities for each phase of cardiac arrest with VF as the initial underlying rhythm (defibrillation for the first phase and compression prior to defibrillation for the second phase) seems a rational approach in selecting the proper treatment algorithm for cardiac arrest victims.

Based on the previous data, there is no place for a B in the ABCD sequence in CPR, at least for the first minutes of no respiratory cardiac arrest victims. But this was known decades ago. From a more simplistic point of view the key points for this consideration are the following: 1) in non respiratory cardiac arrest there is enough oxygen content reserve for the victim during the first minutes after collapse just like a person who can tolerate holding his breath especially after hyperventilation for several minutes, 2) the brain seems more tolerant to hypoxia than ischemia, 3) breathing is a complicated and time consuming skill that delays resuscitation, and 4) for esthetic and health reasons the majority of lay persons do not initiate any rescue attempt and this diminishes any survival probability.

Gasping, which is present in a significant number of individuals who collapse due to VF, may play a crucial role during the first minutes of arrest by providing self ventilation (negative intrathoracic pressure). However, gasping may mislead lay rescuers if they interpret it as regular breathing causing them not to initiate resuscitation. To ensure prompt initiation of resuscitation the educational projects must highlight that infrequent shallow noisy gasps are a sign of cardiac arrest and that the sequence of actions known as "chain of survival" must be initiated.

COMPRESSION-ONLY CPR

An attractive alternative for victims of non anoxic cardiac arrest is compression only CPR. This alternative is supported not only by experimental animal studies but also by 5 key human studies comparing the efficacy of bystander compression-only CPR with conventional CPR (Table). In 2000, Hallstrom

Study	Population Studied (All AreOut-of-Hospital)	Outcome Measure
Hallstrom et al, 2000[14]	Prospective, RCT of dispatcher instructions for all adult cardiac arrests, excluding poisoning/overdoses	Discharged alive from hospital
Waalewijn et al, 2001[15]	All bystander-witnessed adult cardiac arrests with EMS resuscitation	Discharged alive from hospital
Nagao et al, 2007[18]	All witnessed adult cardiac arrests–cardiac andnoncardiac causes	Neurologically favorable 1-month survival
Iwami et al, 2007[16]	All witnessed adult cardiac arrests of presumed cardiac origin	Neurologically favorable 1-year survival
Bohm et al, 2007[17]	All cardiac arrests with bystander CPR including cardiac and noncardiac causes	1-month survival

et al[14] demonstrated that the outcome after CPR with chest compression alone is similar to that after chest compression with mouth-to-mouth ventilation. Waalewijn et al[15] reported that the provision of chest compressions alone did not have a negative influence on survival to hospital discharge, compared with conventional CPR.

Three nonrandomized observational studies were published in 2007, and none demonstrated any negative impact on survival with compression only CPR. Iwami et al[16] measured the 1-year survival with favorable neurological outcome and concluded that both methods are similarly effective for most adult out-of-hospital cardiac arrests. Bohm et al[17] also studied 1-month survival and found no statistically significant difference between victims that received chest compressions alone and those that received conventional CPR.

One step ahead the SOS-KANTO[18] study group showed that cardiac only resuscitation was not only equal to the conventional CPR but the preferable approach to resuscitation for adult patients with witnessed out-of-hospital cardiac arrest, especially those with apnea, shockable rhythm, or short periods of untreated arrest.

Under the weight of evidence supported by these studies, the AHA issued a science advisory for the public recommending immediate activation of emergency medical services (EMS) after the victim's collapse and high quality chest compression regarding location and depth with minimum interruptions. Bystanders not trained in CPR are encouraged to initiate immediately hands-only CPR and continue with compressions until an AED is available or EMS arrives at scene. If the bystanders are previously trained in CPR willing and confident about their skills in rescue breaths they are encouraged to proceed either with conventional 30:2 or compression only CPR until AED or EMS arrival. Finally if the lay rescuers are not confident with their skills even if they are trained, it is better to provide a high quality compression CPR.

The Committee acknowledges the concerns raised by the above statements considering victims of non-cardiac medical emergencies (e.g., drowning, drug overdose, pediatric patients and asphyxia arrest victims) who will not benefit from rescue breathing. There is also a time interval in cardiac arrest when the oxygen content becomes essentially low and some kind of ventilation is needed. Finally the cornerstone of this statement is the three observational studies mentioned above and no data retrieved from randomised prospective studies.[19]

The European resuscitation council advisory statement on basic life support on 31/3/2008 emphasized the need to keep the guidelines unchanged based on the fact that there have been no studies published in which chest compression-only CPR has been compared with 30:2 CPR according to the 2005 Guidelines, and the considerably higher percentage of resuscitation attempts (is cited between 27% and 67%) in Europe than that observed in the United States.[15,20]

CARDIO-CEREBRAL RESUSCITATION

An answer to this controversy comes from the university of Tucson Arizona with the cardio-cerebral resuscitation (CCR) (Figure 2). CCR is a new approach for resuscitation of patients with cardiac arrest. It is composed of 3 components: 1) continuous chest compressions for bystander resuscitation; 2) a new EMS algorithm CCR which discourages endotracheal intubation and consists of 200 chest compressions and a single defibrillation shock that is immediately followed by 200 more chest compressions before rhythm and pulse analysis; and 3) aggressive post-resuscitation care that includes both the use of therapeutic mild hypothermia and emergent cardiac catheterization and percutaneous coronary intervention (PCI) when appropriate.

CONCLUSION

Awaiting the ILCOR guidelines slated for October 18, 2010, there are some predictions on the possible changes. A simpler universal algorithm for all lay rescuers, easy to be taught and remembered, shall be addressed emphasizing minimal delay in rescue efforts initiation with high quality CPR. For professional rescuers and EMS personnel a more flexible approach, taking into account the victims with respiratory arrest, seems more appropriate. The role of ventilation shall be minimized but not totally abandoned taking into consideration the role of breathing even in cardiac arrest victims when the duration of resuscitation exceeds a certain time interval. Finally post resuscitation care using newer innovative techniques such as mild therapeutic hypothermia and early coronary intervention for acute coronary syndrome highly suspected victims is a matter of high priority given that return of spontaneous circulation (ROSC) is not synonymous with good neurological outcome and hospital discharge.

REFERENCES

1. 2005 American Heart Association guidelines for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation* 2005; 112(Suppl IV):IV-1–IV-211.
2. International Liaison Committee on Resuscitation. 2005 International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. *Resuscitation* 2005; 67:181–341.
3. Brenner BE, Kauffman J. Reluctance of internists and medical nurses to perform mouth-to-mouth resuscitation. *Arch Intern Med* 1993;153:1763-1769.
4. Safar P, Brown TC, Holtey WJ. Failure of closed chest cardiac massage to produce pulmonary ventilation. *Dis Chest* 1962;41:1-8.

5. Aufderheide TP, Sigurdsson G, Pirrallo RG, et al. Hyperventilation induced hypotension during cardiopulmonary resuscitation. *Circulation* 2004;109:1960–1965.
6. Berg RA, Kern KB, Sanders AB, et al. Cardiopulmonary resuscitation: bystander cardiopulmonary resuscitation: is ventilation necessary? *Circulation* 1993;88:1907–1915.
7. Berg RA, Kern KB, Hilwig RW, et al. Assisted ventilation does not improve outcome in a porcine model of single-rescuer bystander cardiopulmonary resuscitation. *Circulation* 1997;95:1635–1641.
8. Lawes EG, Baskett PJF. Pulmonary aspiration during unsuccessful cardiopulmonary resuscitation. *Intensive Care Med* 1987;13:379–382.
9. Kern KB, Hilwig RW, Berg RA, et al. Efficacy of chest compression-only BLS CPR in the presence of an occluded airway. *Resuscitation* 1998;39:179–188.
10. Yannopoulos D, Aufderheide TP, Gabrielli A, et.al. Clinical and hemodynamic comparison of 15:2 and 30:2 compression-to-ventilation ratios for cardiopulmonary resuscitation. *Crit Care Med* 2006;34:1444 –1449.
11. Valenzuela T, Kern K, Clark L, et al. Interruptions of chest compressions during emergency medical systems resuscitations. *Circulation* 2005;112:1259–1265.
12. Weisfeldt M, Becker L. Resuscitation after cardiac arrest: a 3-phasetime-sensitive model. *JAMA* 2002;288:3035–3038.
13. Berg MD, Clark LL, Valenzuela TD, et al. Post-shock chest compression delays with automated external defibrillator use. *Resuscitation* 2005;64:287–291.
14. Hallstrom A, Cobb L, Johnson E, et al. Cardiopulmonary resuscitation by chest compression alone or with mouth-to-mouth ventilation. *N Engl J Med* 2000;342:1546 –1553.
15. Waalewijn RA, Tijssen JG, Koster RW. Bystander initiated actions in out-of-hospital cardiopulmonary resuscitation: results from the Amsterdam Resuscitation Study (ARRESUST). *Resuscitation* 2001;50:273–279.
16. Iwami T, Kawamura T, Hiraide A, et al. Effectiveness of bystander-initiated cardiac-only resuscitation for patients with out-of-hospital cardiac arrest. *Circulation* 2007;116:2900 –2907.
17. Bohm K, Rosenqvist M, Herlitz J, et al. Survival is similar after standard treatment and chest compression only in out-of-hospital bystander cardiopulmonary resuscitation. *Circulation* 2007;116:2908–2912.
18. Cardiopulmonary resuscitation by bystanders with chest compression only (SOS-KANTO): an observational study. *Lancet* 2007;369:920–926.
19. Sayre MR, Berg RA, Cave DM, et al. Hands-only (compression-only) cardiopulmonary resuscitation—a call to action for bystander response to adults who experience out-of-hospital sudden cardiac arrest. *Circulation* 2008;117:2162–2167.
20. Herlitz J, Bahr J, Fischer M, et al. Resuscitation in Europe: a tale of five European regions. *Resuscitation* 1999;41:121-31